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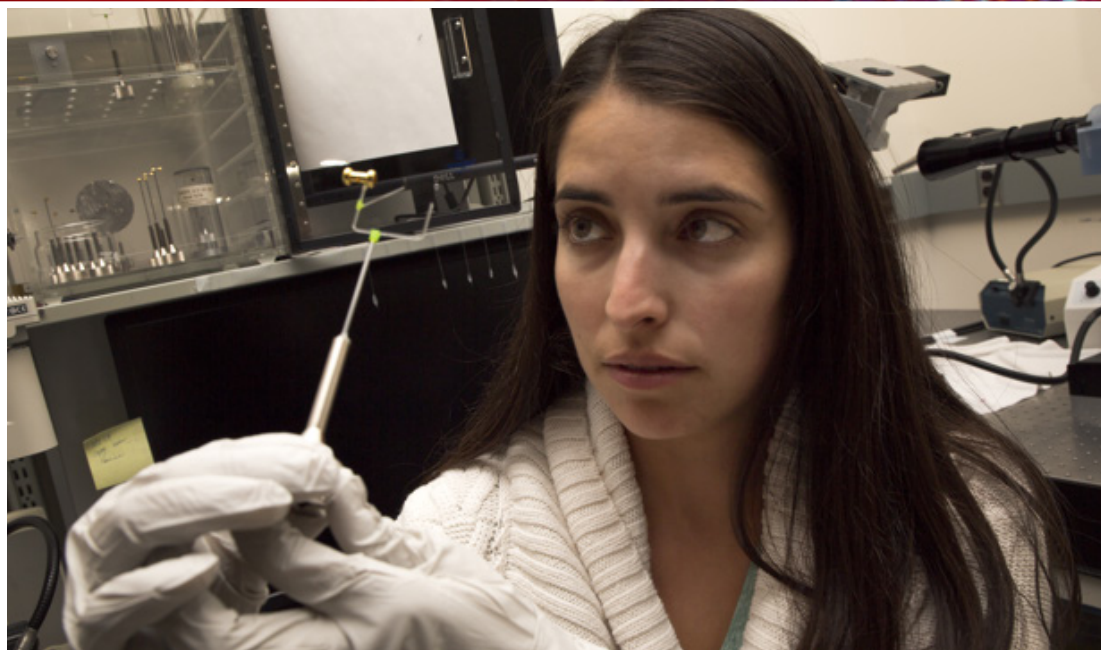
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Tana Cardenas at work on a target for an opacity shot in September at the National Ignition Facility.

Photo by Carlos Trujillo, NIE-CS

Tana Cardenas

Engineering solutions to national security challenges

By Eileen Patterson, CPA-CAS

“
Someone asked me
what I wanted to be, and
I said, ‘I’m going to be a
mechanical engineer.’”

”

As a child in Galisteo, New Mexico, Tana Cardenas liked to walk around the house with a screwdriver, tightening every loose screw she saw. And, when she was eight years old, she said she remembered, “Someone asked me what I wanted to be, and I said, ‘I’m going to be a mechanical engineer.’”

Cardenas was true to her word. She is now an R&D engineer on the Target Engineering team in Engineered Materials (MST-7) where she designs targets Los Alamos physicists put in the path of lasers at the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory and the Omega laser facility at the University of Rochester. The experimental campaigns at NIF and Omega serve Stockpile Stewardship and the efforts to achieve ignition: energy-producing inertial confinement fusion.

Derek Schmidt, a senior target engineer Cardenas considered her mentor, said he sees her as a bright, hard-working engineer possessed of natural leadership ability. “She is leading some of our most visible and critical campaigns for

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WALK WITH A MANAGER

Voice your ideas, your perspective, your concerns with an MST manager in the casual and refreshing environment of the great outdoors.

During the months of October and November, MST managers are available to staff interested in getting together for informal walking and talking meetings. You could also arrange to walk to lunch with a manager.

The event is part of ADEPS's health and wellness initiative aimed at promoting a healthy, safe, and productive workforce. Additionally, participants can receive a 250-point Virgin Pulse voucher.

Nothing is off the table; topics are yours to decide.

So don your sensible shoes, bring a water bottle, and walk with a manager!

To make an appointment:

With David Teter or Jon Bridgewater, contact Monica Roybal, mgr@lanl.gov, 665-1535

With Dom Peterson or Kim Obrey, contact Lola Sandoval, lolas@lanl.gov, 667-6887

With Ellen Cerreta, contact Esther Palluck, epalluck@lanl.gov, 665-4735

With David Pugmire, contact Ariana Roybal, alroy@lanl.gov, 667-4665



Tana Cardenas cont.

LANL,” he said, “and doing a spectacular job balancing customer service and professionalism within our stressful working environment.”

Cardenas’s projects include the Marble and Double Shell projects, which focus on how the material mix in a target’s physics package reacts to shock and intense radiation. Her work begins when physicists bring her their target specifications. She translates their ideas into reality and produces an initial design that is then altered and refined in collaboration with the clients. “We meet frequently to make sure I’m accurately interpreting what they need,” she said, “but it’s always a balance between what they want and what is physically possible. I help them meet the balance.”

Cardenas uses computer-aided design software to draw, at the size of a monitor screen, targets that will be small enough to perch on a fingertip. The same software lets her digitally assemble the target and place it in a virtual mockup of the NIF or Omega target chambers. Both NIF and Omega may host a project’s completed targets because NIF experiments are often preceded by shots on Omega.

“You get only two or three shots at a time on NIF,” Cardenas explained, “and it’s very expensive. By trying some things out on Omega, the researchers get more data at less cost and learn new pieces to validate their codes. Then at NIF, their shots are more robust because they’ve practiced on Omega.”

For finished target designs, external companies fabricate some of the components, such as the capsules and simple components. Fellow team members at the Target Fabrication Facility machine many of the other, more developmental components. Cardenas helps orchestrate the manufacturing time for all the processes and works closely with machinists and scientists to solve any problems. The facility also houses target assembly, an exacting procedure requiring magnified optics and custom robotic stages as well as the use of toothpicks and thin glue sticks for positioning and adhering all the parts.

Projects also need what Cardenas called “rudimentary objects.” These trussed structures are designed for holding and positioning target components in the assembly. She designs and models these for additive manufacturing. Her work space has additive machines, but if an object will be used at NIF, an outside company produces it, using a proprietary NIF-approved substance called MicroFine Green. Cardenas has noticed that those objects tend to come back slightly oversized, so she accounts for the sizing anomaly in her designs.

A challenge facing Cardenas and her fellow team members is related to the Double Shell project, which is named for the double-shelled target it requires. Designing that target to be successfully machined is difficult because the target will include a tube that could easily be broken. The design and assembly methods have to accommodate that tube. “I have no idea how we’ll do that,” Cardenas said, and then smiled. “But we will.”

Tana Cardenas’s favorite experiment

What: To better quantify the gold M-band radiation drive in hohlraums for future platform uses at NIF.

Why: Drive variability can often overwhelm the physics sensitivity in laser-based radiation flow experiments.

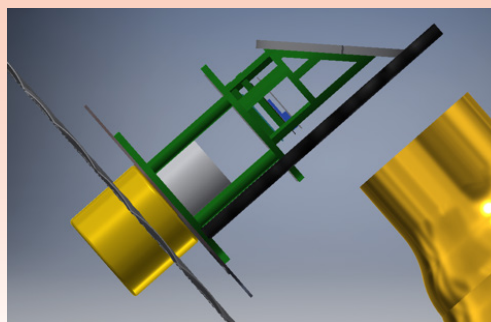
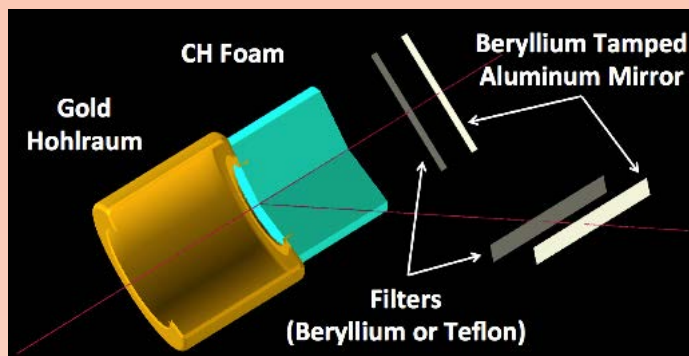
When: August 31, 2015

Where: The National Ignition Facility at Lawrence Livermore National Laboratory

Who: John Kline, Nick Lanier, Derek Schmidt, and others in Plasma Physics (P-24) and Engineered Materials (MST-7)

How: My task was to design a target to meet the physical needs of the experiment. The designers of an experiment know where in space they want components placed, but it is up to me to figure out how to accurately place them—a very complicated task because of the material, space, and weight constraints. I was able to achieve the complex design with the help of additively manufactured support structures (the green structures in the figures).

The “a-ha” moment: This was the first NIF experiment I was responsible for and also the first experiment in which I was working on a new design rather than on an established platform. I can hardly pinpoint something I did not learn while coordinating this platform. I learned a lot about designing, managing the fabrication of developmental parts, and figuring out how to create new procedures for assembling and metrologizing a target for the first time.



Above, an experimental schematic from N. E. Lanier, et al., *Rev. Sci. Instrum.* (in process). At left, a solid model of the target support structure.

MST staff in the news

Cerreta named ASM fellow

ASM International named Ellen Cerreta (Materials Science in Radiation and Dynamics Extremes, MST-8) to the 2016 class of Fellows. Recipients of one of the highest honors in the field of materials, ASM Fellows are technical and professional leaders who have been recognized by their colleagues and serve as advisors to the society. Cerreta was cited for "outstanding contributions in the fields of dynamic and shock behavior of materials, as well as structure/property effects on mechanical behavior and damage evolution in materials."



She holds a Ph.D. in materials science and engineering from Carnegie Mellon University. Cerreta joined the Laboratory as a postdoctoral associate and is the MST-8 group leader. Her research focusing on the correlation of microstructure to mechanical response of metals supports the weapons, global security, Office of Basic Energy Sciences, and Laboratory Directed Research and Development programs. She is an adjunct faculty member in the Institute of Shock Physics at Washington State University and serves on the TMS board of directors and ASM board of trustees.

ASM International is dedicated to serving the materials science and engineering profession. Through its network of 36,000 members worldwide, ASM provides authoritative information and knowledge on materials and processes, from the structural to the nanoscale. Cerreta will be honored at an October ASM International awards dinner in Salt Lake City, Utah.

Technical contact: Ellen Cerreta

American Nuclear Society recognizes Maloy

Stuart Maloy (Materials Science in Radiation and Dynamics Extremes, MST-8) has won the 2014 American Nuclear Society (ANS) Materials Science and Technology Division (MSTD) Outstanding Achievement Award. The society recognized him for "his work on structural materials development and characterization of neutron-irradiated materials."



The award recognizes those individuals who have made unique or sustained outstanding achievements in the field of materials science and technology contributing to the development of nuclear energy.

In addition, Stuart and his co-authors (T.A. Saleh [Nuclear Materials Science, MST-16], O. Anderoglu [MST-8], T.J. Romero [Inorganic Isotope and Actinide Chemistry, C-IIAC]), G.R. Odette, T. Yamamoto, S. Li (UC, Santa Barbara) and J.I. Cole, R. Fielding (Idaho National Laboratory) won the 2015 ANS MSTD Literary Award intended to recognize authors that have contributed the best full-length materials-oriented paper or review article in the field of materials science and technology contributing to the development of nuclear energy for the paper, "Characterization and comparative analysis of the tensile properties of five tempered martensitic steels and an oxide dispersion strengthened ferritic alloy irradiated at $\approx 295^\circ\text{C}$ to ≈ 6.5 dpa," by : S.A. Maloy, T.A. Saleh, O. Anderoglu, T.J. Romero, G.R. Odette, T. Yamamoto, S. Li, J.I. Cole, R. Fielding, *Journal of Nuclear Materials*, **468**, 232-239 (2016).

At Los Alamos National Laboratory, Maloy leads research on the development of advanced materials for core materials applications in fast reactors including the development of tempered martensitic steels and oxide dispersion strengthened steels. Research includes testing highly irradiated materials at the CMR wing 9 hot cells and testing and development of advanced materials at the Materials Science Laboratory.

He has been a technical staff member at Los Alamos for 27 years and is the advanced reactor core materials technical leader for the Fuel Cycle Research and Development's Advanced Fuels campaign at the Laboratory. He earned his PhD in materials science from Case Western Reserve University and is a registered professional engineer in metallurgy. Maloy has applied his expertise to characterizing and testing the properties of metallic and ceramic materials in extreme environments, such as under neutron and proton irradiation at reactor relevant temperatures. He has more than 170 peer-reviewed technical publications and numerous presentations. He recently became the reactor materials technical lead for the DOE-Office of Nuclear Energy (DOE-NE) programs Nuclear Energy Enabling Technologies program. His position is part of the reactor materials crosscut effort supporting the development of revolutionary materials and providing broad-based, modern materials science benefiting DOE-NE objectives.

The American Nuclear Society, an international organization with approximately 11,000 engineers, scientists, administrators, and educators, is dedicated to promoting awareness and understanding with regard to the application of nuclear science and technology. Maloy received the award at the ANS meeting in New Orleans in June.

Technical contact: Stuart Maloy

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Staff cont.

Vogel named to ESS's Scientific and Technical Advisory Panel for Engineering and Imaging



Sven Vogel (Materials Science in Radiation and Dynamics Extremes, MST-8) was appointed to the Scientific and Technical Advisory Panel for Engineering and Imaging for the European Spallation Source (ESS) by Ken Andersen, head of the Neutron Instruments Division of the European Spallation Source. Once operating at full power, the ESS, which is under construction in Lund, Sweden, will be the most powerful neutron source in the world. Vogel will advise on the design of the ODIN imaging beamline as well as the engineering diffractometer BEER.

He was selected for this position by Markus Strobl, deputy head of the Instrument Division of ESS, due to his combination of expertise in both engineering neutron diffraction as well as advanced neutron-imaging techniques. Vogel's appointment is for up to four years. A member of MST-8's scattering team, Vogel is the instrument scientist for the HIPPO (high pressure/preferred orientation) neutron diffractometer and the energy-resolved neutron imaging beam line at the Los Alamos Neutron Science Center.

Technical contact: Sven Vogel

MST students in the news

Fifteen MST student researchers present at the annual student symposium

The Laboratory's Annual Student Symposium is designed to provide students with the opportunity to present their research, thereby broadening their capabilities and preparing them for careers in science and nontechnical fields. It also lets presenters network and make professional contacts. The following participated in the 16th annual event.

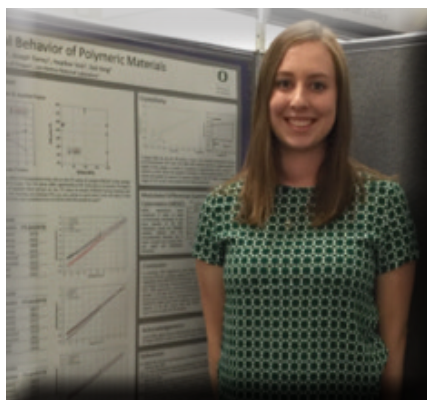
Jillian Adams (Engineered Materials, MST-7) presented research on "Anisotropic Thermal Behavior of Polymeric Materials." Her mentor is Michael Blair (MST-7).

Robert Gianan (MST-7) presented research "Thermal Characterization of HDPE and UHMWPE." His mentor is Cynthia Welch (MST-7).

Sally Grindstaff (MST-7) presented research on "Measuring Glass Transition Temperature with 2D FT-IR." Her mentor is Robert Gilbertson (MST-7).

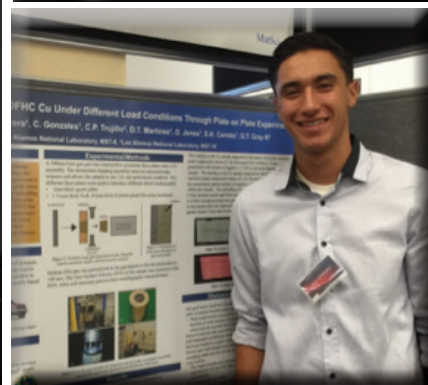
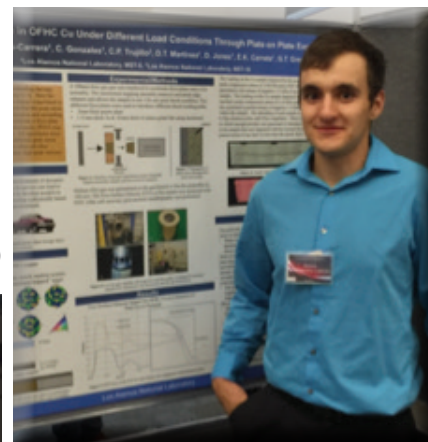
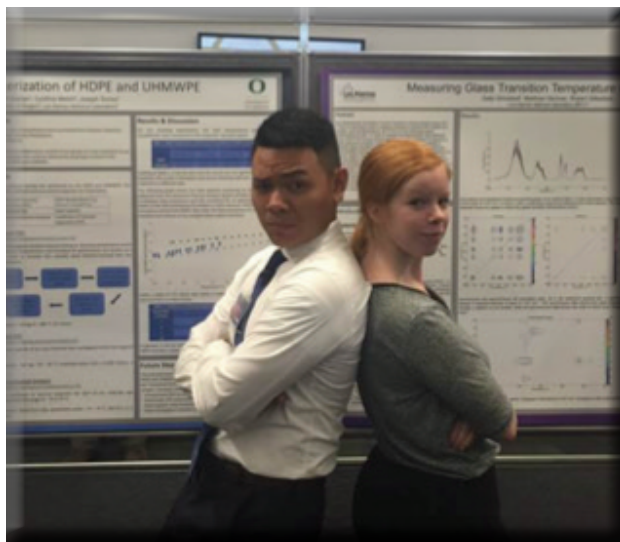
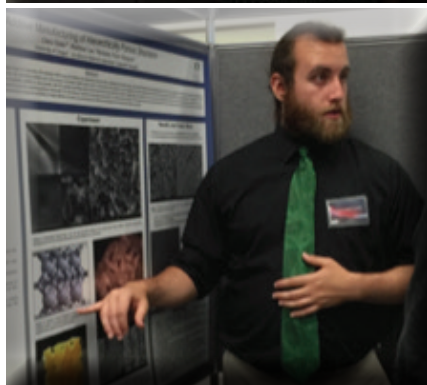
Christopher Grote (MST-7) presented research on "Additive Manufacturing of Hierarchically Porous Structures." His mentor is Matthew Lee (MST-7).

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Clockwise from top left: Jillian Adams (MST-7), Ernest Miramontes-Carrera (MST-8), Cisco Gonzales (MST-8), Robert Gianan (MST-7) and Sally Grindstaff (MST-7); Christopher Grote (MST-7).

Photos by Jennie Keller (MST-7)



Students cont.

Reuben Peterson (MST-7) presented research on “SEM Study of Protective Coatings Applied to Stainless Steel.” His mentor is Igor Usov (MST-7).

Katherine Ramos (MST-7) presented research on “Image Based Modeling Using 3D Tomography.” Her mentor is Brian Patterson (MST-7).

Olivia Trautschold (MST-7) presented research on “Moisture Sorption and Desorption of Silicone Foam.” Her mentor is Robert Gilbertson (MST-7).

Robert Grote (Materials Science in Radiation & Dynamics Extremes, MST-8) presented research on “Hollandite Radiation Response.” His mentor is Ming Tang (MST-8).

Cisco Gonzales (MST-8) presented research on “Probing Damage in OFHC Cu Under Different Load Conditions.” His mentor is Carl Trujillo (Nuclear Materials Science, MST-16).

Nicholas Brown (MST-8) presented research on “Environment-Dependent Interfacial Properties for a Nickel Crystal-Melt System.” His mentor is Enrique Martinez Saez (MST-8).

Matthew Chancey (MST-8) presented research on “Fission Fragment Damage Studies.” His mentor is Ellen Cerreta (MST-8).

Ernest Miramontes-Carrera (MST-8) presented research on “Probing Damage in OFHC Cu Under Different Load Conditions.” His mentor is Carl Trujillo (MST-16).

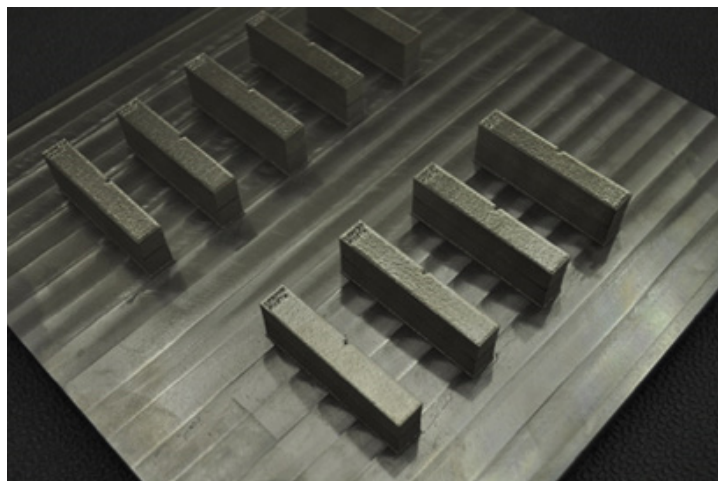
Miroslav Zecevic (MST-8) presented research on “Modelling Deformation and Recrystallization of Uranium.” His mentor is Rod McCabe (MST-8).

Samuel Schwarm (MST-8) presented research on the “Thermal Aging of Duplex Stainless Steels As Measured by Multiscale Mechanical Methods.” His mentor is Stuart Maloy (MST-8).

Elliot Kisiel (MST-16) presented research on “First Principles Determination of Structural Variations in δ -Pu from Self-Irradiation.” His mentor is Franz Freibert (MST-16).

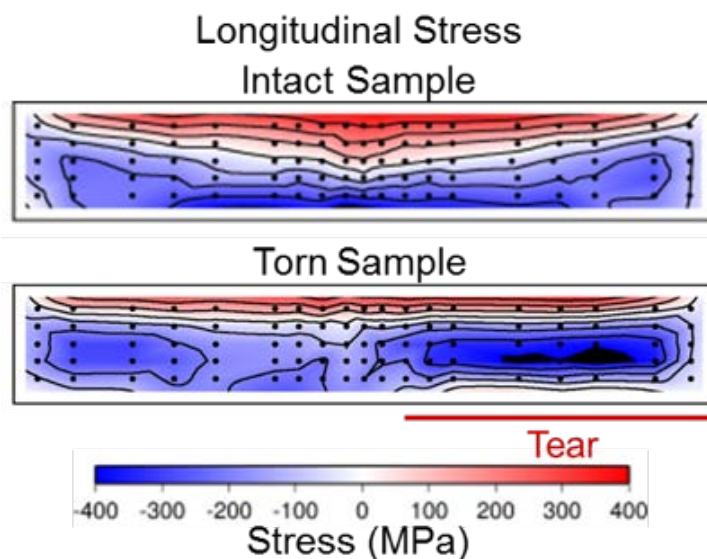
SMARTS reveals residual stresses in additively manufactured parts

At the Lujan Center, an experiment using SMARTS, the spectrometer for materials research at temperature and stress, revealed how build failure affects residual stresses in additively manufactured parts. Understanding how residual stress develops during additive manufacturing is critical to qualify parts for critical applications.



Above, stainless steel samples additively manufactured on a steel base plate. A sample near the edge tore away from the base plate during the build.

Below, data showing that stress in the intact sample provides a large bending moment, likely driving the tear. In turn, the tear alters the heat flow and constraint on the part from the base plate. The tear between the support mesh and the build plate results in an asymmetric stress field in the part that remains after removal from the plate.



In the experiment, 14 stainless steel samples were additively manufactured on a steel base plate—one nearer the edge of the plate than is usually attempted. SMARTS was used to measure residual stresses in several (4) of the parts. In general, the residual stresses in all of the parts were within the measurement uncertainty of each other, despite differing processing parameters, with the exception of the one near the edge. The edge sample, in particular, was unique in that the mesh sub-structure on which that sample was built tore from the base plate during the build. This altered the heat flow out of the part as well as the mechanical constraint of the part during deposition, resulting in a significantly different residual stress field. The implication is that this part will

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SMARTS cont.

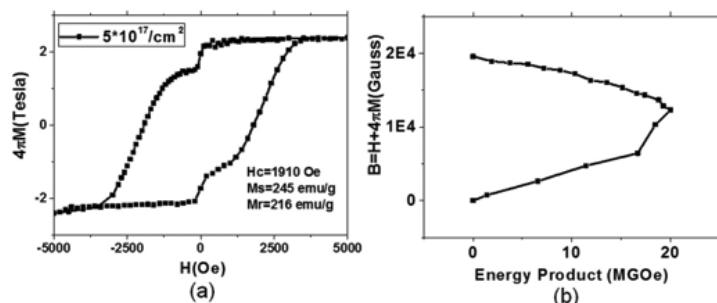
distort differently than the parts that did not tear when removed from the base plate, and could be out of dimensional tolerance. Moreover, the different residual stress could affect the performance, i.e. time to failure, of the part. Understanding the sensitivity of the part to factors that may change (e.g. powder conditions or laser power) and how it may change in processing is critical to qualifying the manufacturing process. The work has been accepted for publication in *Materials Science and Engineering A*.

The Lujan Center at the Los Alamos Neutron Science Center provides unique hardware and software capabilities for rapid bulk microstructural characterization to accelerate qualification of additively manufactured materials. These results are an example of decades of experience with large data-sets that provide foundation for data analysis of MaRIE experiments in material discovery. MaRIE is the Laboratory's proposed experimental facility for Matter-Radiation Interactions in Extremes. Participants include Don Brown and Bjorn Clausen (Materials Science in Radiation and Dynamics Extremes, MST-8), John Carpenter (Sigma Division), and John Bernardin, James Thompson, and Dusan Spornjak (Applied Engineering Technology, AOT-1). Science Campaign 1 and Directed Stockpile Work (DSW) funded the research, which supports the Laboratory's Stockpile Stewardship mission and Materials for the Future Science Pillar.

Technical contact: Don Brown

First-ever rare-earth free permanent magnets with 20 MGOe energy product

A team of researchers from the University of Minnesota, Los Alamos National Laboratory, and Oak Ridge National Laboratory has prepared the first-ever rare-earth-free magnet with 20 MGOe. The finding was recently published in *Scientific Reports* (www.nature.com/articles/srep25436). Commentary quickly followed in *Electronics Weekly* (www.electronicweekly.com/news/research-news/rare-earth-free-magnet-made-from-cheap-materials-2016-05/).



Characterization results of a bulk Fe_{16}N_2 free-standing foil prepared by the nitrogen ion implantation method with $5 \times 10^{17}/\text{cm}^2$ fluence (a) In-plane hysteresis loops for the sample at room temperature, showing $H_c = 1910$ Oe, $M_s = 245$ emu/g, $M_r = 216$ emu/g; (b) The calculated energy product, indicating maximum value 20 MGOe; (c) The X-ray diffraction spectrum, showing the Fe_{16}N_2 phase generated in the foil; (d) The HRTEM diffraction pattern of FeN sample with $5 \times 10^{17}/\text{cm}^2$ fluence, showing Fe_{16}N_2 , $\text{Fe}_4\text{N}/\text{Fe}_{4-x}\text{Ni}_x\text{N}$ and Fe phases.

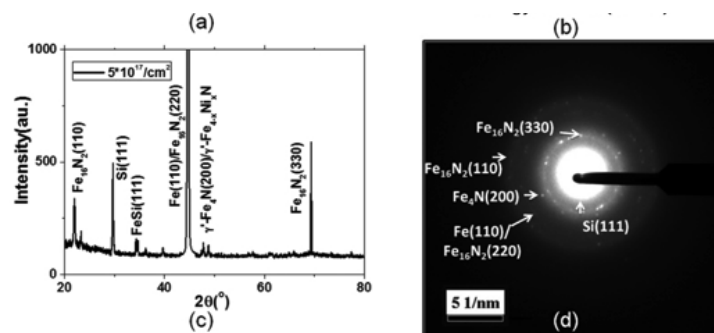
Rare-earths are expensive, the extraction process is energy intensive and hazardous for the environment, and the supply chain is dominated by a specific region of the world. All these pose a great problem when the world has to depend on rare-earth-based permanent magnets for running motors, generators, sensors, and many other machines and devices. The group of researchers synthesized a rare-earth-free permanent magnet based on $\alpha''\text{-Fe}_{16}\text{N}_2$. The raw material is abundant and cheap, and the processing of the material is manufacturable into the bulk scale. This is the first-ever demonstration of energy product of 20 MGOe (figure of merit for permanent magnets) from a rare-earth free magnet.

The researchers prepared a 500-nm $\alpha''\text{-Fe}_{16}\text{N}_2$ foil by first implanting a high fluence of nitrogen ions in a pure iron matrix and followed by a two-step thermal annealing process to engineer the foil in obtaining the high energy product. With the tunable capability of the ion implantation fluence and energy, a microstructure with grain size of 25–30 nm is constructed on the FeN foil sample with the implantation fluence of $5 \times 10^{17}/\text{cm}^2$.

Reference: "Synthesis of Fe_{16}N_2 compound Free-Standing Foils with 20 MGOe Magnetic Energy Product by Nitrogen Ion-Implantation," *Scientific Reports* 6 (2016).

The work was led by Jian Ping Wang (University of Minnesota). Yanfeng Jiang and Md A Mehedi (University of Minnesota) worked on the project in collaboration with Engang Fu and Yongqiang Wang (Materials Science in Radiation and Dynamics Extremes, MST-8) and Lawrence Allard (Oak Ridge National Laboratory). The project was funded by ARPA-E (Advanced Research Project Agency-Energy). LANL participation, including ion implantation, was supported by the Center for Integrated Nanotechnologies, a DOE nanoscience user facility operated by Los Alamos and Sandia national laboratories. The work supports the Laboratory's energy security mission and materials for the future science pillar.

Technical contact: Yongqiang Wang



Got news?

MST e-News highlights science and technical accomplishments from across MST Division and has a distribution that includes Laboratory staff and senior management as well as external readers. If have unclassified news you'd like to see featured, please send it to your group leader to be forwarded to ADEPS Communications Project Manager Karen Kippen.



Celebrating service

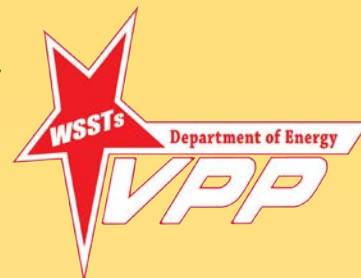
Congratulations to the following MST Division employees celebrating service anniversaries recently:

Randall Randolph, MST-7	30 years
Gerald Rivera, MST-7	30 years
Glenda Bustos, MST-16	25 years
David Teter, MST-DO.....	20 years
Angelique Wall, MST-16	20 years
Michael Ramos, MST-16	20 years
Carlos Tome, MST-8.....	20 years
Stewart Voit, MST-8.....	10 years
Kevin Henderson, MST-7	10 years
John Martinez, MST-7	10 years
Ming Tang, MST-8	10 years
Sarah Hernandez, MST-16.....	5 years
Joseph Torres, MST-7	5 years
Eric Weis, MST-7	5 years
Benjamin Morrow, MST-8	5 years

HeadsUP!

Lab safety, security programs showcased at national VPP conference

The Department of Energy highlighted Laboratory employee-driven safety and security initiatives at the 32nd Voluntary Protection Program national conference in Kissimmee, Fla.



Deputy Laboratory Director Rich Kacich, Deputy Principal Associate Director for Operations (PADOPS) Bill Mairson, and Associate Director for Environment, Safety, and Health (ADESH) Michael Brandt, along with several LANL employees, gave presentations on topics ranging from operational leadership and implementation of learning teams to how ergonomic improvements have reduced risk of injury, improved productivity, reduced error rate, and improved the comfort of employees. Other Laboratory presentations included LANL Radio and the Lab's workplace violence prevention program.

In 2014 the Laboratory received Voluntary Protection Program Star Status from the Department of Energy, the largest site in the DOE complex to attain this status. DOE will be conducting its next VPP assessment in September 2017.



Materials Science and Technology

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To submit news items or for more information, contact Karen Kippen, ADEPS Communications, at 505-606-1822, or adeps-comm@lanl.gov.

For past issues, see www.lanl.gov/org/padste/adepts/mst-e-news.php.



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